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EFFECT OF MICRONUTRIENTS AND MULCHING ON GROWTH AND YIELD OF BROCCOLI (*Brassica oleracea* var. *italica* L.)

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ABSTRACT

A field experiment was conducted in the Horticulture Farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh to study the effect of micronutrients and mulching on growth, yield of broccoli. The experiment was laid out in factorial randomized block design with three replications. The experiment consisted of four levels of micronutrients (T_0: No micronutrients, T_1: $Zn_{4.0}$ kg/ha, T_2: $Zn_{4.0}$ + $B_{1.5}$ kg/ha, T_3: $Zn_{4.0}$ + $B_{1.5}$ + $Mo_{1.0}$ kg/ha) and three levels of mulching (M_0: No mulch, M_1: Water hyacinth, M_2: Black polythene). Micronutrients and mulching influenced significantly on most of the parameters. The data were recorded on various growth and yield parameters of broccoli. In case of micronutrients, the highest curd yield (24.20 t/ha) was found from T_3 and the lowest curd yield (18.44 t/ha) was found from T_0. Regarding the treatment of mulching, M_2 gave the highest curd yield (25.23 t/ha) where the lowest (15.29 t/ha) was recorded from M_0. Considering the treatment combinations, the highest curd yield (28.76 t/ha) was obtained from T_3M_2 and the lowest yield (12.97 t/ha) was found from T_0M_0 treatment combination.

Keywords: micronutrients, mulching, growth, curd yield, broccoli

INTRODUCTION

Broccoli (*Brassica oleracea* var. *italica* L.), belongs to family Cruciferae, is a member of cole group. It contains carbohydrates (5.5 %), protein (3.3 %), vitamin-A (3500 IU), vitamin-C (137 mg), vitamin-B1 (0.05 mg), vitamin-B_2 (0.12 mg), calcium (0.80 mg) and phosphorus (0.79 mg) (Shatis Xaxa *et al.*, 2018). Broccoli has 4.0, 2.5 and 2.0 times more riboflavin, calcium and ascorbic acid content, respectively as, compared to cauliflower (Hazra and Som, 1999). It is also rich source of sulphoraphane which is associated with reducing the risk of cancer. The average yield of broccoli is low in Bangladesh compared to other countries. However, low yield may be attributed to a number of reasons viz. unavailability of quality seeds of high yielding varieties, fertilizer management, disease and insect infestation and improper or limited irrigation facilities. Among different factors nutrients can play an important role for increasing the production of quality broccoli (Ambrosini *et al.*, 2015).

Micronutrients play an important role in broccoli production. Among the micro elements, Zn, B and Mo play an important role directly and indirectly in improving the growth, yield and quality of broccoli. Zinc (Zn) is responsible for many important physiological functions. It has different role in plants metabolic activities. Cell division, nitrogen and carbohydrate metabolism and water relation in plant are controlled by B. In its absence, nutritional disorders in vegetables like hollow stem in cauliflower and broccoli (Shelp, 1990). In Cole crops like cauliflower and broccoli, boron requirement is high (Mengal and Kirkby, 1987). Molybdenum is involved in several enzyme systems and is also required in the synthesis of ascorbic acid and is implicated in making iron physiologically available in plants. Broccoli is cultivated in Bangladesh during the winter season when rainfall is scanty. Mulching can minimize the requirement of water and helps in retaining moisture (Amal *et al.*, 1990). It acts as surface barrier to check evaporation to water from soil surface. Black polyethylene is popular for vegetable production in cool season because it warms the soil by contact (Hochmuth *et al.*, 2008).

Mulches significantly enhanced root growth and facilitated higher nutrient uptake, thereby, promoting growth and development of plants (Kumar and Rawat, 2002). Mulching and fertilization influence the water and nutrient supply to the plant and can affect the nutritional composition of the harvested curd. Hence, keeping in view the above facts in mind present investigation is framed to study the effect of micronutrients and mulching on the growth, yield contributing characters and yield of broccoli.

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MATERIALS AND METHODS

The present work was conducted at Horticulture Farm, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh. The experiment consists of twelve treatment combinations with four micronutrients (T_0: No micronutrients, T_1: $Zn_{4.0}$ kg/ha, T_2: $Zn_{4.0}$ + $B_{1.5}$ kg/ha, T_3: $Zn_{4.0}$ + $B_{1.5}$ + $Mo_{1.0}$ kg/ha) and three levels of mulching (M_0: No mulch, M_1: Water hyacinth, M_2: Black polythene) in Factorial Randomized Block Design with three replications. The unit plot size was 2m x 1.8 m. A basal dose of half of the nitrogen @ 120 kg ha^{-1}, full dose of phosphorous @ 100 kg ha^{-1} was applied at the time of land preparation and potassium @ 150 kg ha^{-1} was applied in three equal installments at 15, 30 and 45 days after transplanting where Nitrogen was applied into two splits, at the time of transplanting and remaining half after 45 days of transplanting. Micronutrients i.e. Zinc as Zinc sulphate, Boron as boric acid and molybedenum as ammonium molybdate were collected from local market. Total 110.97 g zinc were appled in 27 zinc treated plot, whereas 57.15 g B were appled in 18 B treated plot and 6.0 mg Mo were applied in 9 M_o treated plot as basal dose. Mulching was done before transplanting of seedling and two types' *viz.*, water hyacinth and black polythene mulch were used. The fresh water hyacinth was chopped into small pieces (5 cm) and sun dried for three days before placing and black polythene sheet with small opening which was made for maintaining proper plant to plant and row to row distance before placing over the plots. Data was recorded on plant height, stem length, stem diameter, root length, root fresh weight per plant, primary curd weight, primary curd diameter, number of secondary curd per plant, weight of secondary curd, dry matter content of curd, primary and secondary curd yield per plot and primary and secondary curd yield per hectare.

RESULTS AND DISCUSSIONS

Effect of micronutrients on plant height

The plant height of broccoli was varied significantly due to different micronutrients. It was recorded at 15, 30, 45, 60 DAT and at harvest (Table 1). At harvest, the maximum plant height (67.58 cm) was recorded from T_3 treatment, where the shortest plant (61.76 cm) was found from T_0 (No micronutrients) treatment. The result revealed that combined application of Zn, B, M_o was found to produced better growth of broccoli. It may be inferred that the increase in plant height may be done to the favorable influence and balanced absorption of nutrients. Singh *et al.* (2015) reported that application of 120 kg N+ 60 kg P_2O_5+ 40 kg K_2O+15 kg B/ha showed longest plant (65.33 cm).

Table 1. Effect of different micronutrients and mulching on plant height at different days after transplanting (DAT) and at harvest of broccoli

Treatments	Plant height (cm) at				
	15 DAT	30 DAT	45 DAT	60 DAT	Harvest
Micronurtients					
T_0	17.49 c	34.45 c	48.29 c	54.39 c	61.76 c
T_1	19.14 b	36.50 b	51.13 b	58.62 b	64.52 b
T_2	20.33 a	37.87 ab	52.63 ab	59.62 ab	65.46 ab
T_3	21.41 a	39.23 a	54.56 a	61.72 a	67.58 a
$LSD_{(0.05)}$	1.187	1.479	1.979	2.991	2.719
CV (%)	6.19	4.09	5.93	5.22	4.29
Mulching					
M_0	17.15 b	33.42 b	46.70 b	55.22 b	59.11 b
M_1	20.49 a	38.18 a	53.74 a	59.82 a	67.29 a
M_2	21.15 a	39.45 a	54.22 a	60.77 a	68.18 a
$LSD_{(0.05)}$	1.028	1.281	1.714	2.590	2.355
CV (%)	6.19	4.09	5.93	5.22	4.29

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

T_0: No micronutrients, T_1: $Zn_{4.0}$ kg/ha, T_2: $Zn_{4.0}$ + $B_{1.5}$ kg/ha, T_3: $Zn_{4.0}$ + $B_{1.5}$ + $Mo_{1.0}$ kg/ha

M_0: No mulch, M_1: Water hyacinth mulch, M_2: Black polythene mulch

Effect of mulching on plant height

Different mulching showed statistically significant variation in terms of plant height at 15, 30, 45, 60 DAT and at harvest (Table 1). At harvest, the highest plant height (68.18 cm) was observed from M_2 (Black polythene mulch, while the shortest plant (59.11 cm) was recorded from M_0 treatment. In the present study black polythene mulching may accounted for retaining favorable maintain moisture and a more uniform temperature distribution in the soil than non-mulch soil which making more nutrients elements available for promoted plants. Mulching in broccoli give earlier longest plant (Ali, 2004).

Interaction effect of micronutrients and mulching on plant height

Combined effect of different micronutrients and mulching showed statistically significant differences on plant height of broccoli at 15, 30, 45, 60 DAT and at harvest. At harvest, the tallest plant (71.04 cm) was found from T_3M_2 treatment combination, whereas the shortest plant (54.61 cm) was observed from T_0M_0 treatment combination (Table 2).

Table 2. Combined effect of different micronutrients and mulching on plant height at different days after transplanting (DAT) and at harvest of broccoli

Treatments	Plant height (cm)				
	15 DAT	30 DAT	45 DAT	60 DAT	Harvest
T_0M_0	15.29 e	31.44 g	44.45 f	49.72 e	54.61 d
T_0M_1	18.48 d	35.50 d-f	50.15 cd	55.85 cd	64.55 bc
T_0M_2	18.70 d	36.40 c-f	50.28 cd	57.60 b-d	66.43 ab
T_1M_0	18.34 d	34.57 ef	46.80 d-f	56.72 b-d	60.43 c
T_1M_1	19.47 cd	37.00 c-e	53.63 bc	59.51 a-d	66.60 ab
T_1M_2	19.62 cd	37.94 cd	52.97 bc	59.83 a-d	66.52 ab
T_2M_0	17.30 de	33.88 fg	46.34 ef	55.71 d	60.03 c
T_2M_1	21.14 bc	39.06 bc	54.61 ab	61.47 a-d	67.64 ab
T_2M_2	22.56 ab	40.68 ab	55.74 ab	61.69 a-c	68.73 ab
T_3M_0	17.67 d	33.77 fg	49.22 de	58.73 a-d	61.35 c
T_3M_1	22.85 ab	41.11 ab	56.58 ab	62.46 ab	70.36 a
T_3M_2	23.70 a	42.79 a	57.89 a	63.97 a	71.04 a
$LSD_{(0.05)}$	2.055	2.561	3.428	5.180	4.710
CV (%)	6.19	4.09	5.93	5.22	4.29

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

T_0: No micronutrients, T_1: $Zn_{4.0}$ kg/ha, T_2: $Zn_{4.0}$ + $B_{1.5}$ kg/ha, T_3: $Zn_{4.0}$ + $B_{1.5}$ + $Mo_{1.0}$ kg/ha

M_0: No mulch, M_1: Water hyacinth mulch, M_2: Black polythene mulch

Effect of micronutrients on stem length, stem diameter and root length and roots fresh weight per plant

Statistically significant variation was recorded among stem length, stem diameter, root length and roots fresh weight per plant of broccoli due to different micronutrients (Table 3). The longest stem (21.97 cm), highest stem diameter (2.92 cm), the longest root (23.55 cm) and highest roots fresh weight per plant (31.76 g) was recorded from T_3 treatment which was statistically similar (21.42 cm) to T_2 treatment and closely followed (20.39 cm) by T_1 treatment, whereas the shortest stem (19.76 cm), shortest root (21.96 cm), the lowest roots fresh weight per plant (30.10 g), lowest stem diameter (2.29 cm) was found from T_0 treatment (Table 3). Singh *et al.* (2015) reported the maximum stem diameter (4.47 cm), whereas in control condition it was minimum.

Effect of mulching on stem length, stem diameter, root length and roots fresh weight per plant

Different mulching showed statistically significant variation in terms of stem length, stem diameter, root length and roots fresh weight per plant of broccoli. The longest stem (23.09 cm) was observed from M_2 treatment which closely followed (21.35 cm) by M_1 treatment, while the shortest stem (18.22 cm) was attained from M_0 treatment (Table 3). The highest stem diameter (2.92 cm), longest root (25.12 cm), highest roots fresh weight per plant (32.32 g) was found from M_2 treatment where the

lowest root, stem growth obtained from M_0 treatment (Table 3). It might be due to the retention of adequate soil moisture conserved properly by the black polythene mulch, which subsequently helped in increasing stem length, stem diameter, root length and finally the root fresh weight.

Table 3. Effect of different micronutrients and mulching on stem length, stem diameter, and roots length and roots fresh weight per plant of broccoli

Treatments	Stem length of (cm)	Stem diameter (cm)	Root length of (cm)	Roots fresh weight plant^{-1} (g)
Micronutrients				
T_0	19.76 c	2.29 c	21.96 b	30.10 b
T_1	20.39 bc	2.55 b	22.92 ab	30.87 ab
T_2	21.42 ab	2.72 ab	23.43 a	31.65 a
T_3	21.97 a	2.92 a	23.55 a	31.76 a
$LSD_{(0.05)}$	1.278	0.196	1.087	1.295
CV (%)	6.26	7.60	4.84	4.26
Mulching				
M_0	18.22 c	2.35 c	20.65 c	29.90 c
M_1	21.35 b	2.59 b	23.13 b	31.07 b
M_2	23.09 a	2.92 a	25.12 a	32.32 a
$LSD_{(0.05)}$	1.106	0.169	0.941	1.122
CV (%)	6.26	7.60	4.84	4.26

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

T_0: No micronutrients, T_1: $Zn_{4.0}$ kg/ha, T_2: $Zn_{4.0}$ + $B_{1.5}$ kg/ha, T_3: $Zn_{4.0}$ + $B_{1.5}$ + $Mo_{1.0}$ kg/ha
M_0: No mulch, M_1: Water hyacinth mulch, M_2: Black polythene mulch

Interaction effect of micronutrients and mulching on stem length, stem diameter, root length and roots fresh weight per plant

Combined effect of different micronutrients and mulching showed statistically significant differences. In T_3M_2 treatment combination showed height result in case of stem length, stem diameter, root length and roots fresh weight per plant that was close to T_3M_1 treatment combination where minimum growth was observed from T_0M_0 treatment combination (Table 4).

Table 4. Combined effect of different micronutrients and mulching on stem length, stem diameter, and roots length and roots fresh weight per plant of broccoli

Treatments	Stem length of (cm)	Stem diameter (cm)	Root length of (cm)	Roots fresh weight plant^{-1} (g)
T_0M_0	17.57 f	2.16 f	19.48 g	28.56 e
T_0M_1	20.33 de	2.25 f	22.76 c-e	31.12 b-e
T_0M_2	21.37 c-e	2.46 d-f	23.64 cd	30.61 c-e
T_1M_0	19.25 ef	2.38 ef	21.41 e-g	30.92 c-e
T_1M_1	20.05 de	2.49 d-f	22.89 c-e	30.26 c-e
T_1M_2	21.85 b-d	2.68 c-e	22.36 de	30.43 c-e
T_2M_0	16.92 f	2.20 f	19.90 fg	28.99 de
T_2M_1	21.88 b-d	2.77 b-d	24.46 bc	31.43 a-d
T_2M_2	23.15 a-c	2.93 bc	24.52 bc	32.48 a-c
T_3M_0	19.15 ef	2.68 c-e	21.80 d-f	31.11 b-e
T_3M_1	24.18 ab	3.05 b	25.89 ab	33.49 ab
T_3M_2	24.92 a	3.39 a	26.49 a	33.74 a
$LSD_{(0.05)}$	2.213	0.339	1.883	2.243
CV (%)	6.26	7.60	4.84	4.26

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

T_0: No micronutrients, T_1: $Zn_{4.0}$ kg/ha, T_2: $Zn_{4.0}$ + $B_{1.5}$ kg/ha, T_3: $Zn_{4.0}$ + $B_{1.5}$ + $Mo_{1.0}$ kg/ha
M_0: No mulch, M_1: Water hyacinth mulch, M_2: Black polythene mulch

Effect of micronutrients on primary curd diameter, weight, no. of secondary card per plant and wt. of secondary curd

This observation represents that the primary curd diameter (9.26 cm), weigh (492.05 g), no. of secondary card per plant (3.03) and wt. of secondary curd (75.50 g) were maximum under the micronutrients treatment T_3 and the lowest from T_0 treatments (Table 5). Firoz *et al.* (2008) reported that the application of B at 1.0 kg/ha had the height curd weight (294.6 g) and 2.0 kg B showed the next result (270.2 g).

Effect of mulching on primary curd diameter, weight, no. of secondary card per plant and wt. of secondary curd

The highest primary curd diameter, weight, no. of secondary card per plant and wt. of secondary curd was obtained from M_2 and lowest from M_0 (Table 5). These results indicate that black polythene create favorable condition for the growth of plant effectively. Black polythene mulch retention of adequate soil moisture which leads to production of the maximum diameter of curd and curd weight.

Table 5. Effect of different micronutrients and mulching on primary curd diameter, primary curd weight, secondary curd number and secondary curd weight of broccoli

Treatments	Primary curd diameter (cm)	Primary curd weight (g)	Number of secondary curd plant^{-1}	Secondary curd weight (g)
Micronutrients				
T_0	8.31 b	396.10 d	2.54 d	60.91 d
T_1	8.79 a	445.54 c	2.72 c	66.95 c
T_2	9.02 a	464.12 b	2.88 b	70.91 b
T_3	9.26 a	492.05 a	3.03 a	75.50 a
$LSD_{(0.05)}$	0.455	14.63	0.076	1.951
CV (%)	5.27	5.33	6.85	4.91
Mulching				
M_0	8.35 b	329.16 c	2.35 c	55.00 c
M_1	8.97 a	501.49 b	2.94 b	73.87 b
M_2	9.22 a	517.71 a	3.09 a	76.83 a
$LSD_{(0.05)}$	0.394	12.67	0.066	1.689
CV (%)	5.27	5.33	6.85	4.91

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

T_0: No micronutrients, T_1: $Zn_{4.0}$ kg/ha, T_2: $Zn_{4.0} + B_{1.5}$ kg/ha, T_3: $Zn_{4.0} + B_{1.5} + Mo_{1.0}$ kg/ha
M_0: No mulch, M_1: Water hyacinth mulch, M_2: Black polythene mulch

Interaction effect of micronutrients and mulching on primary curd diameter, primary curd weight, number of secondary card per plant and weight of secondary curd

Combined effect of different micronutrients and mulching showed statistically significant differences on primary curd diameter of broccoli. The highest diameter of primary curd (9.68 cm), primary curd weight (569.66 g), secondary curd per plant (3.47), secondary curd weight (84.54 g) was recorded from T_3M_2 which was statistically similar to T_3M_1, whereas the lowest primary and secondary curd weight, diameter and number of secondary curd were found from T_0M_0 treatment combination (Table 6).

Effect of micronutrients on dry matter content of curd, curd yield per plot (kg) and curd yield per ha (ton)

Maximum dry matter content of curd (13.80 g), highest curd yield per plot (8.71 kg) and curd yield/hectare (24.20 ton) was found from T_3 treatment while the lowest dry matter content of curd (13.10 g), lowest curd yield per plot (6.64 kg) and lowest curd yield per hectare (18.44 ton) were found

from T_0 treatment (Table 7). Zhang *et al.* (2007) reported that the yield of broccoli showed marked improvement with the application of different fertilizers.

Effect of mulching on dry matter content of curd, curd yield per plot (kg) and curd yield per ha (ton)

Mulching showed significant effect on dry matter content and curd yield. This might be due to the fact that use of black polythene mulch efficiently controlled weed growth by inhibiting photosynthesis conserved more soil moisture in rhizosphere, created etiolated conditions in plant rhizosphere there by increased root growth and more uptake of nutrients from the soil by the plants. This situation ultimately resulted in increased yield and produce better quality of curds (Bola *et al.*, 2017).

Table 6. Combined effect of different micronutrients and mulching on primary curd diameter, primary curd weight, secondary curd number and secondary curd weight of broccoli

Treatments	Primary curd diameter (cm)	Primary curd weight (g)	Number of secondary curd plant^{-1}	Secondary curd weight (g)
T_0M_0	8.07 e	281.35 f	2.17 g	49.78 h
T_0M_1	8.23 c-e	449.70 d	2.70 d	65.04 e
T_0M_2	8.64 b-e	457.26 d	2.77 d	67.92 e
T_1M_0	8.16 de	341.14 e	2.33 f	54.29 g
T_1M_1	9.01 a-d	494.23 c	2.83 d	72.21 d
T_1M_2	9.09 a-c	501.25 c	3.00 c	74.36 cd
T_2M_0	8.18 de	342.03 e	2.50 e	55.94 g
T_2M_1	9.21 ab	507.67 c	3.00 c	76.27 c
T_2M_2	9.33 ab	542.67 b	3.13 b	80.52 b
T_3M_0	9.00 a-d	352.13 e	2.40 ef	60.00 f
T_3M_1	9.53 ab	554.36 ab	3.23 b	81.96 ab
T_3M_2	9.68 a	569.66 a	3.47 a	84.54 a
$LSD_{(0.05)}$	0.789	25.34	0.131	3.379
CV (%)	5.27	5.33	6.85	4.91

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

T_0: No micronutrients, T_1: $Zn_{4.0}$ kg/ha, T_2: $Zn_{4.0}$ + $B_{1.5}$ kg/ha, T_3: $Zn_{4.0}$ + $B_{1.5}$ + $Mo_{1.0}$ kg/ha
M_0: No mulch, M_1: Water hyacinth mulch, M_2: Black polythene mulch

Table 7. Effect of different micronutrients and mulching on dry matter content in curd and yield per plot and hectare of broccoli

Treatments	Dry matter content of curd (%)	Curd yield (both primary and secondary) plot^{-1} (kg))	Curd yield (both primary and secondary) hectare^{-1} (ton)
Micronutrients			
T_0	13.10 b	6.64 d	18.44 d
T_1	13.53 ab	7.56 c	21.01 c
T_2	13.77 a	8.05 b	22.37 b
T_3	13.80 a	8.71 a	24.20 a
$LSD_{(0.05)}$	0.511	0.196	0.546
CV (%)	3.86	5.60	5.60
Mulching			
M_0	13.23 b	5.51 c	15.29 c
M_1	13.53 ab	8.64 b	24.00 b
M_2	13.89 a	9.08 a	25.23 a
$LSD_{(0.05)}$	0.442	0.169	0.473
CV (%)	3.86	5.60	5.60

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

T_0: No micronutrients, T_1: $Zn_{4.0}$ kg/ha, T_2: $Zn_{4.0}$ + $B_{1.5}$ kg/ha, T_3: $Zn_{4.0}$ + $B_{1.5}$ + $Mo_{1.0}$ kg/ha
M_0: No mulch, M_1: Water hyacinth mulch, M_2: Black polythene mulch

Interaction effect of micronutrients and mulching on dry matter content of curd, curd yield per plot(kg) and curd yield per ha (ton)

Interaction between various factors under study was found to be non-significant for most of the parameters (Table 8). An interaction between micronutrients and mulching revealed the maximum dry matter content of curd (14.28 g) and curd yield (10.35 kg) from T_3M_2 that was statistically significant with T_3M_1 where the lowest result obtained from T_0M_0 treatment combination (Table 8).

Table 8. Combined effect of different micronutrients and mulching on dry matter content in curd and yield of broccoli

Treatments	Dry matter content of curd (%)	Curd yield (both primary and secondary) plot^{-1} (kg)	Curd yield (both primary and secondary) hectare^{-1} (ton)
T_0M_0	12.59 c	4.67 g	12.97 g
T_0M_1	13.27 a-c	7.50 e	20.84 e
T_0M_2	13.43 a-c	7.74 e	21.51 e
T_1M_0	13.43 a-c	5.61 f	15.59 f
T_1M_1	13.55 a-c	8.39 d	23.29 d
T_1M_2	13.37 a-c	8.69 cd	24.14 cd
T_2M_0	13.16 bc	5.78 f	16.06 f
T_2M_1	13.76 ab	8.84 c	24.56 c
T_2M_2	13.93 ab	9.54 b	26.50 b
T_3M_0	13.62 ab	5.95 f	16.54 f
T_3M_1	14.23 a	9.83 b	27.31 b
T_3M_2	14.28 a	10.35 a	28.76 a
$LSD_{(0.05)}$	0.885	0.339	0.946
CV (%)	3.86	5.60	5.60

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

T_0: No micronutrients, T_1: $Zn_{4.0}$ kg/ha, T_2: $Zn_{4.0}$ + $B_{1.5}$ kg/ha, T_3: $Zn_{4.0}$ + $B_{1.5}$ + $Mo_{1.0}$ kg/ha

M_0: No mulch, M_1: Water hyacinth mulch, M_2: Black polythene mulch

CONCLUSION

It can be concluded from the present investigation that the influence of micronutrients and mulching on the growth, yield and quality traits of broccoli was significant. The application of micronutrients ($Zn_{4.0}$ + $B_{1.5}$ + $Mo_{1.0}$ kg/ha) with black polythene mulch proved to be most effective in increasing the vegetative growth and yield of broccoli.

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REFERENCES

Ali, R.M. 2004. Effect of mulching and different levels of nitrogen fertilizer on the growth and yield of broccoli. M.S. Thesis, Dept. Hort. Bangladesh Agricultural University, Mymensingh, Bangladesh. 79-82 pp.

Amal, K.A., Musln, A.A. and Khan, A.H. 1990. Effect of different mulches on the growth of potato (*Solanum tuberosum* L.) *Bangladesh J. Bot.*, 19(1): 56-60.

Ambrosini, V.G., Voges, J.G., Benevenuto, R.F., Vilperte, V., Silveira, M.A., Brunetto, G. and Ogliari, J.B. 2015. Single-head broccoli response to nitrogen application. *Científica.*, 43: 84-92.

Bola, P.K., Aravindakshan, K. and Suthar, V. 2017. Effect of sowing date and spacing on growth, yield and quality of broccoli (*Brassica oleracea* var. *italica*). *Chem. Sc.i Rev. Lett.*, 6(21): 209-212.

Firoz, Z.A., Jaman, M.S., and Alam, M.K. 2008. Effect of boron application on the yield of different varieties of broccoli in hill valley. *J. Agril. Res.*, 33(3): 655-657.

Hazra, P. and Som, M.G. 1999. Technology for vegetable production and improvement of nutritive value of different vegetables. Naya Prakash, Calcutta.

Hochmuth, G.J., Hochmuth, R.C. and Olson, S.M. 2008. Polyethylene Mulching for Early Vegetable Production in North Florida. Universty of Florida IFAS Extension, 805pp.

Kumar, M. and Rawat, T.S.2002. Effect of nitrogen and spacing on quality and yield of cabbage (*Brassica oleracea* var. *capitata*). *Agril Sci. Digest.*, 22(2): 90-92.

Mengel, K. and Kirkby, E.A. 1987. Principles of Plant Nutrition. 4th edn. Int. Potash Inst., Worblaufen-Bern, Switzerland, 120pp.

Shatis, X. Praveen, C., Radhelal, D., Preeti, T., Mithlesh, G. and Sunny, A.T. 2018. Effect of different micronutrients on head quality of broccoli (*Brassica oleracea* var. *italica*) palam samridhi. *J. Pharmacogn. Phytochem.,* 7(4): 1396-1398.

Shelp, B.J. 1990. The influence of boron nutrition on nitrogen partitioning in broccoli plants. *Com. Soil Sci. and Plant Anal.*, 21(1-2): 49-60.

Singh, M.K., Chand, T., Kumar, M., Singh, K.V., Lodhi, S.K., Singh, V.P. and Sirohi, V.S. 2015. Response of different doses of NPK and boron on growth and yield of Broccoli (*Brassica oleracea* L. var. *italica*) *Int. J. Bio-res. Stress Manag.* 6(1): 108-112.

Zhang, C.X., Xie, Z., Yao, Z. and Wu, Z. 2007. Effects of balanced application of nitrogen, phosphorus and potassium fertilizers on growth and yield of broccoli. *Acta Agric. Shanghai.,* 23(3): 22-25.